Fact Sheet

RHIZOSPHERE-ENHANCED NATURAL BIOREMEDIATION

PROBLEM

Natural bioremediation may be the most cost-effective treatment option for remote, contaminated sites. In cold regions, however, natural remediation is often constrained by a lack of nutrients and sub-strates, coupled with a short growing season. We need to identify means to enhance natural remediation processes in cold regions.

SOLUTION

Rhizosphere enhancement of natural bioremediation may provide a low-cost, effective treatment for contaminated soil. The rhizosphere is the zone of soil adjacent to plant roots; the exudation and sloughing-off of carbon compounds from root surfaces into the rhizosphere enhances microbial activity. The impact of enhanced microbial activity in the rhizosphere on the transformation of certain xenobiotics, such as pesticides, has been documented.

Root-based biotreatment approaches would be especially useful for remote sites where alternatives are limited. Depth of rooting imposes some natural constraints on rhizosphere enhancement, but for less mobile contaminants or permafrost soils, where depth of contaminant penetration is otherwise limited, rhizosphere-enhanced biotreatment is a potentially effective treatment. Because bioremediation rates are often constrained by nitrogen, phosphorus, and carbon co-substrate limitations, nutrient limitations to bio-remediation at remote sites may be overcome by stimulating soil-rhizosphere effects with plant species associated with mycorrhiza or nitrogen-fixing bacteria.

CRREL is investigating cold-tolerant plant species for remote site treatment. In a cooperative effort, researchers at the Waterways Experiment Station (WES) in Vicksburg, Mississippi, are investigating emergent plants for use in treating contaminated sediments.

RESULTS

We have observed that roots of some cold-tolerant plants can grow through soil contaminated with approximately 30,000 mg/kg polyaromatic hydrocarbons (PAHs). In a related study, root growth of one species was stimulated by a model contaminant containing 2000 mg/kg of five organic compounds. These results are significant because the mass transfer of contaminants often limits in-situ treatment strategies, and enhanced root distribution would partially address soil mass-transfer limitations. In the rhizosphere of contaminated soils, we found that organic compound-degrading microorganisms were enriched in relation to the total microbial population for the plant species we studied. Results from these studies suggest that bioremediation may be enhanced in rhizosphere soils. This presents opportunities for managing field systems to promote the synergistic effects of freeze-thaw and rhizosphere phenomena to favor soil cleanup. In addition to our work with terrestrial systems, we are extending these techniques to sediment treatment using aquatic plants.

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